GROUND OPERATIONS TECHNOLOGY FOR THE SIR-C/X-SAR MISSION

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Topic Area: Programs, Missions and Field Experiments
Session Organizer: W. Keydel

SIR-C/X-SAR, the combination of Spaceborne Imaging Radar-C and X-band Synthetic Aperture Radar, is a three-frequency radar remote sensing system, fully polarimetric at L, and C bands. It was flown as a part of the Space Radar Lab on Shuttles STS-59 and STS-68 in 1994. The ground operations system for SIR-C/X-SAR, a joint project of Italy, Germany and the US, is an integration of planning, telemetry and command subsystems. The system operated three processes: pre-flight plan formulation, which allocated available resources (e.g., observation time and geometry, power, downlink capacity) to experiments; an inflight replanning process incorporating late changes into that plan; and a parallel one-hour process using late-sit orbit data to set the radars' operating parameters. This plan-within-a-plan system was robust enough to accommodate the missions' highly adaptive nature, adapting to last-minute changes in field conditions, actual achieved orbit, and Shuttle events.

At the outset of the Project, a team of 52 investigators formed mission science objectives and designed C.x])c.lilllc.tits to achieve them. Most experiments involved field activities at the experiment sites. Pre-mission, target locations were used to design an orbit for the Shuttle. First, ascending node longitude was set to maximize target acquisition ("datatake") opportunities. Second, Shuttle attitude was varied with time so that sites could be acquired to both Shuttle left and right. Finally, telemetry downlinks, live and playback, were fit into the plan. The resulting Science Activity Plan was distributed for verification and fine-tuning several times prior to launch. Astronaut activities (photography, tape changes, etc.) were added to produced the pre-flight Integrated Science Timeline for flight controller and crew use.

During the mission, the preflight plan was divided into 12-hour segments phased to coincide with crew shifts. At launch the second segment was replanned to include field updates, actual attained orbit, other payload and Shuttle activities, and the like. Planning software accommodated any resulting changes into the downlink events and produced a "long-term plan", forwarded to flight controllers and astronauts before the oncoming shift began. This replanning effort continued, always one shift ahead of execution. In the short-term planning process, an updated Shuttle ephemeris was created for each one-hour segment from the long-term plan using latest tracking information. Imaging geometry to acquire each experiment site was updated, and radar parameters were calculated using image quality estimation software. Short-term planning also incorporated a more restricted class of investigator or Shuttle-related changes. Finally, commands for the radars, tape recorders, and associated equipment were generated and uplinked.

The authors thank the development, test and operations teams for SIR-C/X-SAR and the assistance of the Johnson Space Center in making the operation of this payload a success. Parts of the research described in this paper were carried out by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.